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(19)



## (54) ULTRASONIC CLEANING APPARATUS

(71) We, KERRY ULTRASONICS LIMITED, a British Company of Hunting Gate, Wilbury Way, Hitchin, Hertfordshire, do hereby declare the invention for which we pray that a patent may be granted to us and the method by which it is to be performed to be particularly described in and by the following statement:

This invention relates to ultrasonic cleaning apparatus of the kind comprising a tank for containing a liquid in which articles to be cleaned can be immersed and a plurality of ultrasonic transducers in acoustical connection with the tank so as 10 to be capable of transmitting mechanical ultrasonic energy into liquid in the tank thereby producing cavitation in the liquid in known manner. Such apparatus will hereinafter be referred to as being of the 15 kind specified.

The transducers may be either magnetostrictive or piezoelectric and may be secured directly to the external surface of one or more walls (including the bottom 25 wall) of the tank or they may be disposed internally of the tank in a liquid tight housing adapted to be immersed wholly or partly in the liquid.

It is known to employ transducers having resonant frequencies from about 10 30 KHz upwards and various arrangements have been proposed to ensure a measure of tuning between the impedance presented by the tank of liquid (which varies according 35 to the depth of liquid in the tank and the nature of the articles immersed therein for cleaning) and the operational frequency of the transducers, but such arrangements tend to be complex and expensive.

According to the present invention we provide cleaning apparatus of the kind specified wherein said plurality includes first and second transducers arranged 40 to operate at substantially different first and 45 second frequencies respectively, the appar-

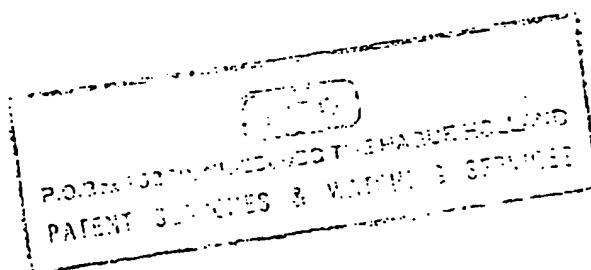
atus including separate first and second power supplies connected to the first and second transducers respectively to energise them at said first and second frequencies respectively.

The transducers of the groups may be distributed uniformly over substantially the same area of the tank. The transducers may be arranged in rows, adjacent transducers in each row operating at different 50 frequencies.

Typical frequencies which may be employed are 25 KHz and 40 KHz although these absolute values are not critical.

By way of example, in order that the 55 invention may more fully be appreciated, it may be stated that we have found that the removal of certain types of soil from articles is very dependant on the frequency of the applied energy, and that in a given case whilst 25 KHz may be almost totally ineffective, 40 KHz may prove satisfactory. However, the application of energy simultaneously at both such frequencies, without increasing the total power employed, may 60 prove superior to the use of either frequency alone as regards the rate of removal 70 of the soil.

In a typical arrangement as indicated in 75 the accompanying drawing, rows of transducers A and B are fixed on the underside of a tank, with alternate transducers in each row designed to operate respectively at 25 KHz and 40 KHz. Separate power supply units  $P_A$  and  $P_B$  providing energising current at the appropriate frequencies are used to drive the two groups of transducers. In a large tank employing, say, 40 transducers it would often be necessary to provide two separate 80 power units, each driving 20 of the transducers, even if they were all designed to operate at the same frequency. Therefore, in accordance with the invention, it is only necessary to employ two power units of 85 90



different operational frequencies instead of two such units operating at the same frequency. The cost of providing for simultaneous operation at two frequencies is therefore not significantly different, in many cases, from that of providing for operation at only a single frequency.

Whilst the reason for improved effectiveness of such cleaning operations when using two different frequencies is not clearly understood, we have observed this effect particularly in relation to cleaning articles by the removal of buffing compounds. However, one effect which is at least partially responsible for an improvement is that when standing waves are produced in the liquid they are more closely spaced than when operating at a single frequency only. Operation at two frequencies has the effect of reducing the dead zone area and hence creating a more uniform energy distribution whilst maintaining the more intense cleaning action due to the lower frequency cavitation effect. For this to be effective the two frequencies must be substantially different, that is to say differing in frequency not merely by 10% or so but rather in the ratio 1 to 1.5 upwards. Thus other suitable combinations of frequencies would be 10/20 KHz, 20/30 KHz, 15/25 KHz, 20/40 KHz.

#### WHAT WE CLAIM IS:—

1. Cleaning apparatus of the kind specified wherein said plurality includes first and second transducers arranged to operate at substantially different first and second frequencies respectively, the apparatus including separate first and second power supplies connected to the first and second transducers respectively to energise them at said first and second frequencies respectively.

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2. Cleaning apparatus of the kind specified wherein said plurality includes first and second groups of transducers arranged to operate at substantially different first and second frequencies respectively, the apparatus including separate first and second power supplies connected to the first and second groups of transducers respectively to energise them at said first and second frequencies respectively.

3. Cleaning apparatus according to claim 2 wherein the transducers of both groups are distributed substantially uniformly over the same area of the tank.

4. Cleaning apparatus according to claim 2 or claim 3 wherein the transducers are arranged in rows, adjacent transducers in each row operating at different frequencies.

5. Cleaning apparatus according to any one of the claims wherein said first and second frequencies differ in the ratio of at least 1 to 1.5.

6. Cleaning apparatus according to claim 5 wherein the first and second frequencies are 25 KHz and 40 KHz.

7. Cleaning apparatus of the kind specified substantially as hereinbefore described with reference to and as shown in the accompanying drawing.

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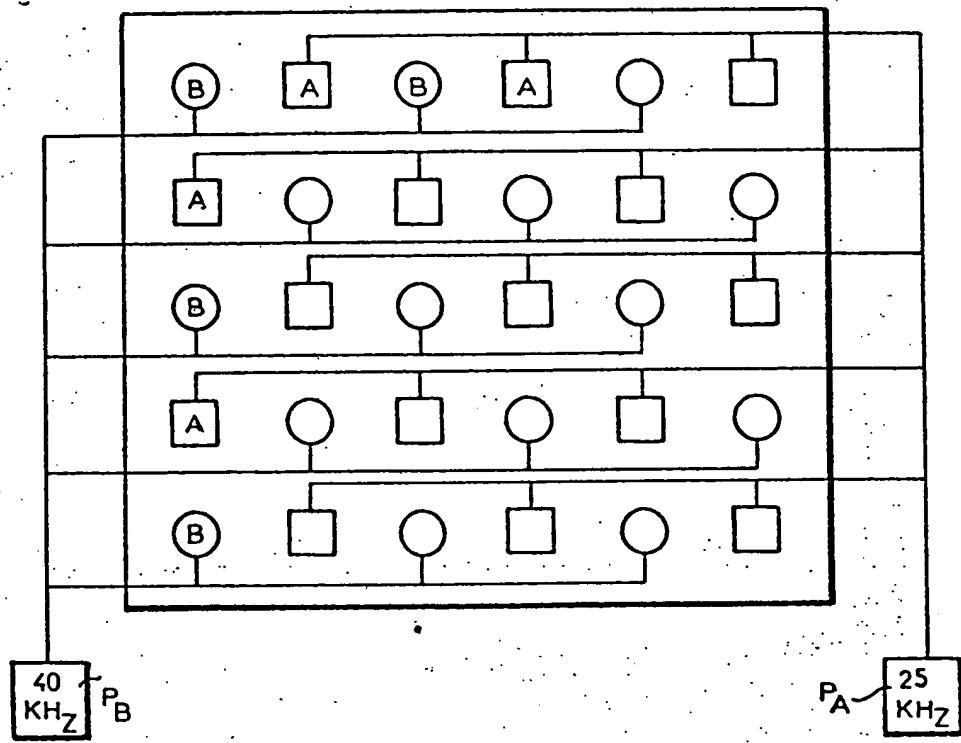
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COMPLETE SPECIFICATION

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